

1     **CLAIMS:**

2     What is claimed is:

3     1. An electronic watermarking system, for embedding  
4     additive information in digital data, for which one frame  
5     is defined as including N samples extracted from digital  
6     data and a current frame is defined as a frame that is  
7     overlapped by M samples ( $0 < M \leq N/2$ ) of a preceding frame,  
8     comprising:

9         (1) a frequency domain transformation unit, for  
10     multiplying a frame extracted from digital data by a  
11     window function, and for using the results to perform a  
12     Fourier transform and thus obtain a frequency component  
13     for said digital data;

14         (2) a frequency domain embedding unit, for employing  
15     bit information for additive information, and a frequency  
16     band for said frequency component to change the amplitude  
17     of said frequency component in said digital data obtained  
18     by said frequency domain transformation unit;

19         (3) a time domain transformation unit, for  
20     performing an inverse Fourier transform to return, to a  
21     time domain signal, said frequency component whose  
22     amplitude has been changed by said frequency domain  
23     embedding unit; and

24         (4) an additive information embedding frame  
25     generator, for multiplying, by a window function, said  
26     time domain signal obtained by said time domain  
27     transformation unit, and for superimposing overlapped

1 frames to generate a frame wherein said additive  
2 information is embedded.

3 2. An electronic watermarking system according to claim  
4 1, wherein, to change said amplitude of said frequency  
5 component of said digital data, said frequency domain  
6 embedding unit (2) employs bit information for additive  
7 information and the values of a mask, determined in  
8 advance in accordance with a frequency band, with which  
9 said frequency component is to be increased or decreased.

10 3. An electronic watermarking system according to claim  
11 2, wherein the values of said mask corresponding to all  
12 the frequencies included in one frequency band are  
13 equalized.

14 4. An electronic watermarking system according to claim  
15 2 or 3, wherein, as the frequency increases, the width of  
16 said frequency band is extended.

17 5. An electronic watermark detection system, for  
18 detecting additive information embedded in digital data,  
19 comprising:

20 (1) a frequency domain transformation unit, for  
21 multiplying a frame extracted from digital data by a  
22 window function, and for performing a Fourier transform  
23 to obtain a frequency component from said digital data;

24 (2) an amplitude storing unit, for obtaining  
25 amplitudes for said frequency components acquired by said  
26 frequency domain transformation unit, and for storing a

1 number of said amplitudes that equals a predetermined  
2 frame count;  
3 (3) a cycle synchronization unit, for employing an  
4 amplitude value stored by said amplitude storing unit to  
5 designate a bit detection start frame; and  
6 (4) a bit detector, for detecting bit information  
7 from embedded additive information beginning at said bit  
8 detection start frame obtained by said cycle  
9 synchronization unit.

10 6. An electronic watermark detection system according to  
11 claim 5, wherein said frequency domain transformation  
12 unit (1) uses the shorter length of said frame than the  
13 length when said additive information is embedded.

14 7. An electronic watermark detection system according to  
15 claim 5, wherein, in order to designate said bit  
16 detection start frame by referring to said amplitude  
17 values, said cycle synchronization unit (3) employs  
18 calculation results obtained by using the values of a  
19 mask that defines, in advance, a frequency component  
20 increase or decrease.

21 8. An electronic watermarking method, for embedding  
22 additive information in digital data, whereby one frame  
23 is defined as including N samples extracted from digital  
24 data, and a current frame is defined as a frame that is  
25 overlapped by M samples ( $0 < M \leq N/2$ ) of a preceding frame,  
26 comprising the steps of:

27 (1) extracting one frame as a current frame from

1 digital data;  
2 (2) multiplying said current frame by a window  
3 function;  
4 (3) performing a Fourier transform for the resultant  
5 current frame to obtain a frequency component for said  
6 current frame;  
7 (4) changing an amplitude of said frequency  
8 component in accordance with bit information for additive  
9 information;  
10 (5) performing an inverse Fourier transform for the  
11 resultant frequency component;  
12 (6) multiplying, by said window function, said  
13 frequency component obtained using said inverse Fourier  
14 transform; and  
15 (7) adding an (N-M)-th sample, from the end of a  
16 preceding frame processed in the same manner as said  
17 steps (1) to (6), to an M-th sample, from the head of  
18 said current frame processed at said step (6), and  
19 generating one new frame including N samples.

20 9. An electronic watermarking method according to claim  
21 8, wherein, at said step (4) of changing said amplitude  
22 of said frequency component, said amplitude is changed by  
23 employing bit information for additive information and  
24 the values of a mask, determined in advance in accordance  
25 with a frequency band, with which said frequency  
26 component is to be increased or decreased.

27 10. An electronic watermarking method according to claim  
28 9, wherein the values of said mask corresponding to all

1 the frequencies included in one frequency band are  
2 equalized.

3 11. An electronic watermarking method according to claim  
4 9 or 10, wherein, as the frequency increases, the width  
5 of said frequency band is extended.

6 12. A method for detecting additive information embedded  
7 in digital data comprising the steps of:

8 (1) extracting one frame including N samples from  
9 digital data;

10 (2) multiplying said frame by a predetermined window  
11 function;

12 (3) performing a Fourier transform for said  
13 resultant frame to obtain a frequency component of said  
14 frame;

15 (4) storing a value for an amplitude of said  
16 frequency component;

17 (5) calculating an optimal start frame for additive  
18 information detection when the stored amplitude value  
19 reaches a predetermined value through said steps (1) to  
20 (4); and

21 (6) detecting bit information for said additive  
22 information beginning at said start frame.

23 13. A method according to claim 12, wherein, at said  
24 step (1) of extracting one frame, uses the shorter length  
25 of said frame than the length when said additive  
26 information is embedded.

1 14. A method according to claim 12, wherein, at said  
2 step (5) of calculating the optimal start frame,  
3 calculation results obtained by using the values of a  
4 mask, which define, in advance, a frequency component  
5 increase or decrease, are employed in order to designate  
6 said bit detection start frame by referring to said  
7 amplitude value.

8 15. An electronic watermarking method for embedding in  
9 digital data  $N$  bits ( $N \geq 1$ ) of additive information  
10 comprising the steps of:  
11 (1) reading sample values, from digital data, up to  
12 an  $R$ -th sample ( $R \geq 1$ );  
13 (2) reading sample values, from said digital data,  
14 following an  $(R+1)$ -th sample;  
15 (3) changing said sample values following said  
16  $(R+1)$ -th sample in accordance with bit information for  
17 additive information; and  
18 (4) adding together the values up to said  $R$ -th  
19 sample in said digital data and the values following said  
20  $(R+1)$ -th sample, changed in accordance with said bit  
21 information for said additive information.

22 16. An electronic watermarking method for embedding in  
23 digital data  $N$  bits ( $N \geq 1$ ) of additive information  
24 comprising the steps of:  
25 (1) reading a sample value from digital data;  
26 (2) starting to change said sample value in  
27 accordance with bit information for additive information,

1 excluding a head bit of said additive information; and  
2 (3) using said changed sample value to generate new  
3 digital data.

4 17. An electronic watermarking method for embedding in  
5 digital data  $N$  bits ( $N \geq 1$ ) of additive information  
6 comprising the steps of:

7 (1) reading a sample value from digital data;  
8 (2) changing said sample value in accordance with  
9 bit information for additive information;  
10 (3) adding noise at random to said changed sample  
11 value; and  
12 (4) using said changed sample value to generate new  
13 digital data.

14 18. An electronic watermarking method for embedding in  
15 digital data  $N$  bits ( $N \geq 1$ ) of additive information  
16 comprising the steps of:

17 (1) reading a sample value from digital data;  
18 (2) changing said sample value in accordance with  
19 bit information for additive information, and setting at  
20 random a case wherein a change is not required; and  
21 (3) using either the changed sample value or the  
22 unchanged sample value to generate new digital data.

23 19. An electronic watermarking method for embedding in  
24 digital data  $N$  bits ( $N \geq 1$ ) of additive information  
25 comprising the steps of:

26 (1) changing digital data by superimposing,

1 inserting, deleting or shifting a specific sample of said  
2 digital data;  
3 (2) reading a sample value from said digital data;  
4 (3) changing said sample value in accordance with  
5 bit information for additive information; and  
6 (4) using said changed sample value to generate new  
7 digital data.

8 20. An electronic watermarking method for embedding in  
9 digital data  $N$  bits ( $N \geq 1$ ) of additive information  
10 comprising the steps of:  
11 (1) expanding or compressing digital data along a  
12 time axis;  
13 (2) reading a sample value from said digital data;  
14 (3) changing said sample value in accordance with  
15 bit information for additive information; and  
16 (4) using said changed sample value to generate new  
17 digital data.

18 21. An electronic watermarking method for embedding in  
19 digital data  $N$  bits ( $N \geq 1$ ) of additive information  
20 comprising the steps of:  
21 (1) reading a sample value from said digital data;  
22 (2) changing said sample value in accordance with  
23 bit information for additive information;  
24 (3) using said changed sample value to generate new  
25 digital data; and  
26 (4) expanding or compressing said new digital data  
27 along a time axis.



1 22. An electronic watermarking method according to claim  
2 20 or 21, wherein an expansion/compression rate for the  
3 digital data does not exceed 1%.

4 23. An electronic watermarking method for embedding in  
5 digital data  $N$  bits ( $N \geq 1$ ) of additive information  
6 comprising the steps of:

7 (1) re-sampling digital data at a sampling frequency  
8  $r'$  and reading a sample value from said digital data;

9 (2) changing said sample value in accordance with  
10 bit information for additive information; and

11 (3) sampling said changed sample value at the  
12 original sampling frequency  $r$  to generate new digital  
13 data.

14 24. An electronic watermarking method for embedding in  
15 digital data  $N$  bits ( $N \geq 1$ ) of additive information  
16 comprising the steps of:

17 (1) sampling digital data at a sampling frequency  $r'$   
18 and reading a sample value from said digital data;

19 (2) obtaining a change in said sample value in  
20 accordance with bit information for additive information;

21 (3) re-sampling said change at a sampling frequency  
22  $r$  for the original digital data; and

23 (4) adding said re-sampled change to said original  
24 digital data to generate new digital data.

25 25. A computer-readable recording medium on which a  
26 program for embedding additive information in digital  
27 data is stored, said program defining one frame as

1 including N samples extracted from digital data and  
2 defining a current frame as a frame that is overlapped by  
3 M samples ( $0 < M \leq N/2$ ) of a preceding frame, and permitting  
4 a computer to execute:

5 (1) a frequency domain transformation function, for  
6 multiplying a frame extracted from digital data by a  
7 window function, and for using the results to perform a  
8 Fourier transform and thus obtain a frequency component  
9 for said digital data;

10 (2) a frequency domain embedding function, for  
11 employing bit information for additive information, and a  
12 frequency band for said frequency component to change the  
13 amplitude of said frequency component in said digital  
14 data obtained by said frequency domain transformation  
15 function;

16 (3) a time domain transformation function, for  
17 performing an inverse Fourier transform to return, to a  
18 time domain signal, said frequency component whose  
19 amplitude has been changed by said frequency domain  
20 embedding function; and

21 (4) an additive information embedding frame  
22 generation function, for multiplying, by a window  
23 function, said time domain signal obtained by said time  
24 domain transformation function, and for superimposing  
25 overlapped frames to generate a frame wherein said  
26 additive information is embedded.

27 26. A computer-readable recording medium on which a  
28 program for detecting additive information embedded in  
29 digital data is stored, said program permitting a

1 computer to execute:

2 (1) a frequency domain transformation function, for  
3 multiplying a frame extracted from digital data by a  
4 window function, and for performing a Fourier transform  
5 to obtain a frequency component from said digital data;

6 (2) an amplitude storing function, for obtaining  
7 amplitudes for said frequency components acquired by said  
8 frequency domain transformation function, and for storing  
9 a number of said amplitudes that equals a predetermined  
10 frame count;

11 (3) a cycle synchronization function, for employing  
12 an amplitude value stored by said amplitude storing  
13 function to designate a bit detection start frame; and

14 (4) a bit detection function, for detecting bit  
15 information from embedded additive information beginning  
16 at said bit detection start frame obtained by said cycle  
17 synchronization function.

18 27. An article of manufacture comprising a computer  
19 usable medium having computer readable program code means  
20 embodied therein for causing detection of additive  
21 information embedded into digital data, the computer  
22 readable program code means in said article of  
23 manufacture comprising computer readable program code  
24 means for causing a computer to effect the steps of claim  
25 12.

26 28. An electronic watermarking system for embedding  
27 additive information into digital data, said system  
28 comprising:

1  
2       a frequency domain transformation unit for  
3 multiplying a current frame extracted from said digital  
4 data by a window function, and for using the results of  
5 the multiplication to obtain a frequency component for  
6 said digital data, wherein a frame in said system is  
7 defined as including a plurality of samples extracted  
8 from the digital data, and a current frame in said system  
9 is defined as a frame that is overlapped by at least one  
10 sample from said plurality of samples of a preceding  
11 frame;

12       a frequency domain embedding unit for employing bit  
13 information for additive information, and for employing a  
14 frequency band for said frequency component in changing  
15 the amplitude of said frequency component in said digital  
16 data obtained by said frequency domain transformation  
17 unit;

18       a time domain transformation unit for performing an  
19 inverse transform to return said frequency component  
20 whose amplitude has been changed by said frequency domain  
21 embedding unit to a time domain signal; and

22       an additive information embedding frame generator  
23 for multiplying said time domain signal obtained by said  
24 time domain transformation unit by the window function,  
25 and for superimposing overlapped frames to generate a  
26 frame wherein said additive information is embedded.

27 29. An electronic watermarking system according to claim  
28 1, wherein in changing said amplitude of said frequency  
29 component of said digital data, said frequency domain

1 embedding unit employs bit information for additive  
2 information and the values of a mask determined in  
3 advance in accordance with a frequency band.

4 30. An electronic watermarking system according to claim  
5 29, wherein the values of said mask corresponding to  
6 frequencies included in one frequency band are equalized.

7 31. An electronic watermark detection system comprising:

8 a frequency domain transformation unit for  
9 multiplying a frame extracted from digital data by a  
10 window function, and for performing a transform to obtain  
11 a frequency component from said digital data, said system  
12 for detecting additive information embedded in the  
13 digital data;

14 (2) an amplitude storing unit for obtaining  
15 amplitudes for said frequency components acquired by said  
16 frequency domain transformation unit, and for storing a  
17 number of said amplitudes that equals a predetermined  
18 frame count;

19 (3) a cycle synchronization unit for employing an  
20 amplitude value stored by said amplitude storing unit to  
21 designate a bit detection start frame; and

22 (4) a bit detector, for detecting bit information  
23 from embedded additive information beginning at said bit  
24 detection start frame obtained by said cycle  
25 synchronization unit.

26 32. An electronic watermark detection system according

1 to claim 31, wherein said frequency domain transformation  
2 unit (1) uses the shorter length of said frame than the  
3 length when said additive information is embedded.

4 33. An electronic watermarking method for embedding  
5 additive information into digital data, said method  
6 comprising:

7 defining a frame as including a plurality of samples  
8 extracted from the digital data;

9 defining a current frame as a frame that is  
10 overlapped by at least one of said plurality of samples  
11 of a preceding frame;

12 extracting one frame as a current frame from digital  
13 data;

14 multiplying said current frame by a window function;

15 performing a transform for the resultant current  
16 frame to obtain a frequency component for said current  
17 frame;

18 changing an amplitude of said frequency component in  
19 accordance with bit information for additive information;

20 performing an inverse transform for the resultant  
21 frequency component;

22 multiplying, by said window function, said frequency  
23 component obtained using said inverse transform;

24 adding an additional sample, from the end of a  
25 preceding frame processed in the same manner as in said  
26 steps of extracting, multiplying, performing, changing,

1 performing and multiplying to a previous sample from the  
2 head of said current frame processed at said step of  
3 multiplying, and;  
4 generating one new frame including the plurality of  
5 samples.

6 34. An article of manufacture comprising a computer  
7 usable medium having computer readable program code means  
8 embodied therein for causing additive information to be  
9 embedded into digital data, the computer readable program  
10 code means in said article of manufacture comprising  
11 computer readable program code means for causing a  
12 computer to effect the steps of claim 33.

13 35. A method for detecting additive information embedded  
14 in digital data comprising the steps of:  
15 extracting one frame including a plurality of  
16 samples from the digital data;  
17 multiplying said one frame by a predetermined window  
18 function to obtain a resultant frame;  
19 performing a transform for said resultant frame to  
20 obtain a frequency component of said resultant frame;  
21 storing a value for an amplitude of said frequency  
22 component;  
23 calculating an optimal start frame for additive  
24 information detection when the stored amplitude value  
25 reaches a predetermined value through said steps of  
26 extracting, multiplying, performing and storing; and  
27 detecting bit information for said additive  
28 information beginning at said start frame.

1 36. An article of manufacture comprising a computer  
2 usable medium having computer readable program code means  
3 embodied therein for causing additive information to be  
4 embedded into digital data, the computer readable program  
5 code means in said article of manufacture comprising  
6 computer readable program code means for causing a  
7 computer to effect the steps of claim 35.

8 37. An article of manufacture comprising a computer  
9 usable medium having computer readable program code means  
10 embodied therein for causing additive information to be  
11 embedded into digital data, the computer readable program  
12 code means in said article of manufacture comprising  
13 computer readable program code means for causing a  
14 computer to effect the steps of claim 8.

15 38. A computer program product comprising a computer  
16 usable medium having computer readable program code means  
17 embodied therein for causing additive information to be  
18 embedded into digital data, the computer readable program  
19 code means in said computer program product comprising  
20 computer readable program code means for causing a  
21 computer to effect the functions of the system in claim  
22 1.

23 39. A computer program product comprising a computer  
24 usable medium having computer readable program code means  
25 embodied therein for causing detection of additive  
26 information embedded into digital data, the computer



1    readable program code means in said computer program  
2    product comprising computer readable program code means  
3    for causing a computer to effect the functions of the  
4    system in claim 5.